

Calcinus hermit crabs from Easter Island, with biogeographic considerations (Crustacea: Anomura: Diogenidae)

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Abstract

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From collections made in 1998 and 1999, three species of *Calcinus* are recorded from Easter I.: *Calcinus pascuensis* Haig, 1974; *C. imperialis* Whitelegge, 1901; and *C. vachoni* Forest, 1958. A redescription of *Calcinus pascuensis* is given and a neotype is selected. Occurrence of *Calcinus imperialis* is confirmed by examination of almost 80 specimens, including many juveniles. *Calcinus vachoni* is recorded for the first time from the island. The Easter I. *Calcinus* fauna is compared with that of other localities in the Pacific, and biogeographic affinities are discussed.

Keywords

Crustacea, Anomura, Diogenidae, *Calcinus*, biogeography, Easter Island

Introduction

Easter Island (27°10'S, 109°20'W), located 3800 km off the Chilean coast, and separated by 2200 km from Pitcairn I. to the west, is the most isolated island in the South Pacific. The coast line is rocky with only a few sandy and cobble beaches. Its climate is subtropical; the surface sea temperature range is 22–24°C in the summer, and 16–18°C in the winter. Although the water is cool, there are extensive amounts of living coral around the island but diversity of coral species is low. Because of its isolated position and high percentages of endemic taxa, and despite a surface area of only 106 km², Easter I., in conjunction with nearby small Sala y Gómez I., 415 km to the east, is usually treated as a distinct biogeographic province in the Pacific (Briggs, 1974).

The Anomura known from the island consist so far of only seven species: *Calcinus pascuensis* Haig, 1974, *Pylopaguropsis garciai* McLaughlin and Haig, 1989, *Petrolisthes extremus* Kropp and Haig, 1994, Albuneidae sp. and *Calcinus imperialis* Whitelegge, 1901 (DiSalvo et al., 1988), *Phylladiorhynchus integristrois* (Dana, 1853) (Baba, 1991), and *Tylaspis anomala* Henderson, 1885 (Lemaitre, 1998). In 1998 and 1999 new intertidal and shallow water collections of hermit crabs were made during the Chilean CIMAR-5 cruise and the American United States National Park Service Expedition to the island. More than a hundred specimens of the

genus *Calcinus* were obtained, with only three species represented: *C. pascuensis* Haig, 1974, *C. imperialis* Whitelegge, 1901, and *C. vachoni* Forest, 1958. Although low in diversity, these new collections are of interest for at least two reasons. First, they allow a redescription of *C. pascuensis*, previously known from only a single incomplete male. Second, they can be used to discuss the biogeographic affinities of Easter I. with neighbouring localities in the Indo-Pacific region.

Materials and methods. Most of the specimens were collected between 16 Aug and 1 Sep 1999, during the United States National Park Service Expedition to Easter Island. The collectors were Christopher B. Boyko, John Tanacredi (United States National Park Service, Gateway), Rick and Susan Reanier, Ellen Marsh, Dennis Hubbard (Oberlin College, Ohio), and Henry Tonnemacher (Seven Seas, Ltd., Virgin Islands). A few additional specimens were collected during a 1998 Expedition (19–24 Aug). The aim of both expeditions was primarily archaeological. Most hermit crabs were collected intertidally by hand, and a few by SCUBA in depths down to 23 m. Other specimens were collected by Guillermo Guzmán, during the oceanographic CIMAR-5 Chilean cruise, on board the *AGOR Vidal Gormaz* from 29 Oct to 15 Nov 1999. The *Calcinus* were collected by hand in the Easter I. locality of Hanga Roa and its adjacent shores. An additional specimen, collected at Easter I. in March 1984 and deposited in the

collections of the Museo Zoológico Universidad de Concepción, Chile, was obtained through the courtesy of Dr J. N. Artigas.

The measurement (mm), shield length, taken from tip of rostrum to posterior edge of the shield, is included for all specimens. Abbreviations are: AMNH, American Museum of Natural History, New York; MNHN, Muséum national d'Histoire naturelle, Paris; MZUC, Museo Zoológico Universidad de Concepción, Chile; P2, P3, second and third pereopods.

Calcinus pascuensis Haig, 1974

Figure 1

Calcinus pascuensis Haig, 1974: 27, figs 1–6 (type locality: Easter I.).—Retamal, 1981: 19.—DiSalvo et al., 1988: 458.—Poupin and McLaughlin, 1998: 24.

Material examined. Neotype (herein selected). Easter I., off Hanga Otea, 26 Aug 1999, 21 m, D. Hubbard, 1 male 5.3 mm (AMNH 18177).

Other specimens (all from Easter I.). Off Ana O Keke, Poike, 1 male 4.0 mm (AMNH 18178), 1 female 3.9 mm (MNHN Pg 5948). Oroí Point, 1 female 1.5 mm (AMNH 18179). Hanga Tee O Vaihu, 1 male 1.8 mm (AMNH 18180). La Pérouse Bay, 2 males 1.9–2.1 mm, 1 female 1.7 mm (AMNH 18181). Piko, 3 males 1.7–2.0 mm, 2 females 1.3–1.7 mm (AMNH 18182). Te Pito Kura, 1 male 3.0 mm, 3 females 1.4–2.2 mm (AMNH 18183). Piko, 1 male 3.6 mm (AMNH 18184). Hanga Roa, 1 male 2.6 mm, 1 female 2.4 mm (MNHN Pg 6092).

Diagnosis. Ocular acicle with a single terminal spine. Chelipeds, P2 and P3 with long and distally plumose setae, typically with club-like aspect. Outer face of left palm regularly convex. Upper margin of right palm with 4 or 5 strong corneous-tipped spines. Dactyls of P2 and P3 equal to or slightly shorter than propodi; distal degree of setation similar for both pereopods, without distal brush of setae on P3. Telson with 2–16 (usually 10) spines on lateral and posterior margins of left posterior lobe, and 2–7 (usually 6) spines on right posterior lobe.

Redescription. Shield 0.8 as broad as long; anterior margin between rostrum and lateral projections slightly concave; anterolateral margin setose; anterolateral plate of branchiostegite armed by row of spinules on dorsal margin. Rostrum broad, obtusely triangular, largely exceeding small lateral projections. Ocular acicle subtriangular, terminated by single acute spine. Ocular peduncle 0.8–1.0 as long as shield, left slightly longer than right; diameter of cornea included 5–7 times in peduncular length (Fig. 1a).

Antennular peduncle extending to distal 0.25 of ocular peduncle; basal segment usually with 3 spinules at ventrolateral distal angle; penultimate segment unarmed; ultimate segment unarmed, equal to 0.33 of shield length. Antennal peduncle reaching to distal 0.33 of ocular peduncle, furnished with long and distally plumose setae. First segment minutely spinose at ventrolateral distal angle. Second segment with dorsolateral distal angle produced, terminating in strong bifid spine; dorsomesial surface inflated, produced as strong spine. Third segment with ventrodorsal spine. Fourth segment with distodorsal spine. Fifth segment long and unarmed. Antennal flagellum overreaching distal end of P2. Antennal acicle surpassing distal end of penultimate segment of antennal peduncle, produced as strong spine, upwardly curved; dorsolateral margin with 2 spines; dorsomesial margin with 2–3 spines.

Left cheliped larger than right (Fig. 1b). Merus subtriangular in cross-section; outer and inner surfaces flat; outer lower margin usually with single spine at distal angle; inner lower margin with 2 or 3 distal spines. Carpus broad, much shorter than merus. Outer face with prominent submedian tubercle, occasionally with few additional smaller tubercles; distolateral margin with small granules or tubercles, spine-tipped in juveniles. Upper margin with single terminal spine and, in smaller specimens, few additional posterior spines. Inner and lower faces smooth. Chela 0.9–1.6 as long as shield and 1.4–2.0 as long as width. Outer face of palm regularly convex, slightly tuberculate; upper margin with row of 6–8 spiny tubercles; outer lower margin rounded, smooth or slightly tuberculate. Inner face rounded, with tuft of setae below articulation of dactyl; inner lower margin somewhat angular with row of faint granules, prolonged by sharp row of tubercles on inner face of fixed finger. Fingers spooned at tips. Dactyl 0.6 time as long as entire chela, with tufts of long setae on outer margin; cutting edge with 2 or 3 large calcareous teeth on proximal 0.5. Fixed finger forming large hiatus with dactyl; cutting edge with large calcareous tooth on distal 0.5, and 1 or 2 smaller teeth on proximal 0.5.

Right cheliped shorter than left, reaching to base of fingers of left chela, or little beyond, when extended (Fig. 1c). Merus compressed; upper margin sharp with few long setae; outer and inner lower margins each with 2 or 3 distal spines. Carpus much shorter than merus; outer face with median tubercle and 1 or 2 additional smaller ones; distal margin with several corneous-tipped tubercles, somewhat eroded in larger specimens, those proximate to upper and lower margins larger than others; upper margin with 3 strong spines, the distalmost one largest. Outer face of chela with distally plumose setae and several tubercles in distal upper half; upper margin with 5 strong corneous-tipped spines. Fingers spooned at tips. Dactyl 0.5 as long as whole chela; upper margin with a double row of 4 or 5 small corneous-tipped spines; cutting edge with two median calcareous teeth. Fixed finger with outer face tuberculate; cutting edge forming small hiatus with dactyl, armed with 2–4 triangular teeth.

P2 noticeably exceeding cheliped (Fig. 1d). Merus as long as propodus; lateral and mesial faces compressed; dorsal and ventral margins with long, distally plumose setae; ventral margin with row of somewhat spiny granules; distolateral angle armed with single spine. Carpus 0.6 as long as propodus; lateral face inflated, mesial face flattened; dorsal margin with strong subdistal spine and smaller posterior spine; ventral margin with few plumose setae. Propodus feebly curved, subovate in cross-section, slightly shorter than shield length, with several tufts of long, distally plumose setae. Dactyl strongly curved, about 0.9 as long as propodus, terminating in strong corneous claw; ventral margin with few long simple setae, armed with 6–9 acute spines. P3 slightly overreaching tip of cheliped (Fig. 1e). Merus about as long as propodus; lateral face smoothly curved; mesial face slightly concave; dorsal and ventral margins with several tufts of long, distally plumose setae; distolateral angle with spine. Carpus 0.7 times as long as propodus; dorsal and ventral margins with plumose setae; dorsodistal margin with strong terminal spine, sometimes with smaller additional posterior spine. Propodus 0.8 as long as shield length, subovate in cross-section, with tufts of long plumose setae mainly near dorsal and ventral margins. Dactyl as long as propodus; setation weak and similar to dactyl of P2; ventral margin with 7–9 acute spines.

Sternite of P3 with anterior lobe subrectangular; ventral surface swollen in 2 rounded projections, furnished with setae. Telson with left posterior lobe considerably larger than right; lateral margin armed with 8–10 spines, posterior margin with 3–6 spines (Fig. 1f). Right posterior lobe regularly curved, without clear separation between posterior and lateral margins, armed with 6–8 spines.

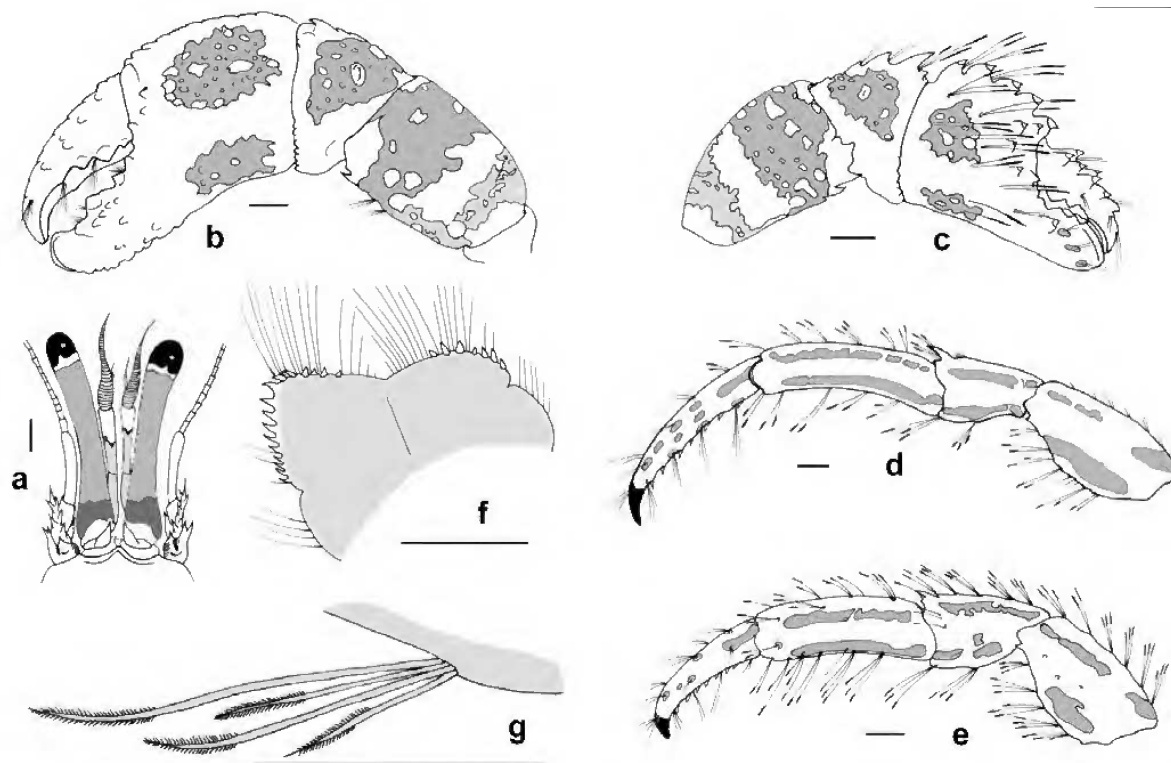


Figure 1. *Calcinus pascuensis* Haig, 1974, neotype male 5.3 mm (AMNH 18177): a, anterior portion of shield and cephalic appendages; b, left cheliped, outer view; c, right chela, outer view; d, left P2, lateral view; e, left P3, lateral view; f, telson, ventral view; g, detail of setae, from ventral margin of P2. Scale bars equal 1 mm. Colour pattern after 18 months in alcohol.

Colour. After 18 months in alcohol, coloration still very clear on larger specimens. Shield orange, fading to white posteriorly. Posterior carapace white. Ocular acicle pink to orange, terminal spine white. Ocular peduncle with basal pink ring (almost white in smaller specimens), median orange area, and narrow white ring close to cornea. Antennular peduncle with dark orange blotches on proximal segment; median segment and proximal half of terminal segment orange; distal half of terminal segment pale blue to white; flagella yellow. Antennal peduncle orange on 4 proximal segments (spines white), yellow on terminal segment and flagellum. Antennal acicle orange with white at tips of spines. Cheliped with large irregular brown patches on pink to cream-white background. Outer and inner faces of merus with brown proximal and distal patches, separated by white median area; outer and inner faces of carpus with median subtriangular brown patches; outer face of chela with 2 brown median patches, a large one on the upper half and a smaller one along ventral margin; inner face of chela with 1 median brown patch. P2 and P3 with pink background. Lateral faces of meri, carpi and propodi with 2 orange brown stripes, forming 2 continuous lines on the 3 segments. Mesial faces with similar pattern, the 2 lines being less regular and reduced to elongated spots on meri and carpi. Dactyls with few elongated orange brown spots. Abdomen and telson white.

Distribution. Easter I.

Habitat. Hard bottoms, from shore to depth of 23 m. Gastropod shells used are: *Coralliophila violacea*, *Nerita* sp., *Planaxis akuana*,

Strombus maculatus, and perhaps also *Erosaria caputdraconis*, *Fossarus cumingii*, *Neothais nesiotis*, and *Nodilittorina pyramidalis pascua* (empty shells of these molluscs were found in vials containing loose crabs of different species).

Remarks. The holotype of *Calcinus pascuensis* was lost during the transfer of the Allan Hancock Foundation collections to the Los Angeles County Museum (G. Davis, pers. comm.). As the original description of the species was based solely on the incomplete holotype, a neotype has been selected herein.

A few morphological variations have been observed. In juveniles smaller than 1.6 mm the ocular peduncles are only 0.6–0.7 times as long as shield instead of 0.8–1.0 in larger specimens. The ocular acicle has typically a single terminal spine on 17 specimens out of 20, but a few other armaments have been observed: 1 additional spinule, unilaterally; two terminal spines on each acicle; and two spines on one acicle and three on the other. The left chela presents several variations according to sex or size. It is usually shorter in females, only 0.9–1.1 times as long as shield versus 1.0–1.6 in males. The aspect of its upper margin varies from almost smooth to armed with a row of six to eight spines. These spines are more acute in juveniles and also cover the upper half of the outer face of the chela. The armament of the telson varies with size. In specimens larger than 3.0 mm, it consists of 11–16 spines on the left posterior

lobe and six to eight on the right posterior lobe. In smaller specimens the number of spines is reduced to two to eight spines on the left posterior lobe and two to three spines on the right posterior lobe.

In armament of the ocular acicle (simple) and telson (several spines on both posterior lobes), aspect of outer face of the left chela (regularly convex), and similar sparse pilosity on distal P2 and P3, *Calcinus pascuensis* is most similar to *C. inconspicuus* Morgan, 1991. However, the two species are easily differentiated by coloration: chelipeds, P2 and P3 in *C. inconspicuus* are almost uniformly coloured while in *C. pascuensis* there are patches on the chelae and stripes on P2 and P3. They also differ in armament of the telson, the spines of the left posterior lobe being present only on the posterior margin in *C. inconspicuus*, whereas they are on the posterior and lateral margins in *C. pascuensis*.

Calcinus pascuensis is distinguishable from the other Indo-West Pacific species by the remarkable coloration of walking legs. A similar pattern is observed in *C. anani* Poupin and McLaughlin, 1998, but the stripes on the propodi and dactyls merge in an intricate network of reticulations. *Calcinus pascuensis* is also unique in the setae on the outer face of the right chela, and on the dorsal and ventral margins of P2 and P3. These setae are distally plumose, which give them a club-like aspect (Fig. 1 g). Although plumose setae are sometimes observed in other species, they are not club-like shaped and are inserted only on the distoventral margins of P2 and P3.

Calcinus imperialis Whitelegge, 1901

Calcinus imperialis Whitelegge, 1901: 48, pl. 9 (type locality: Lord Howe I.).—Grant and McCulloch, 1907: 154.—Chilton, 1911: 552.—DiSalvo et al., 1988: 458.—Morgan, 1991: 882, figs 21–23.—Tudge, 1995: 11, pl. 1, fig. 1f.—Poupin, 1997: 697, figs 3f, 5c, 7d.—Forest et al., 2000: 15.—Forest and McLaughlin, 2000: 79.

Not *Calcinus imperialis*.—Wooster, 1984: 130.—Poupin, 1996: 14 (= *Calcinus isabellae* Poupin, 1997).

Material examined (all from Easter I.). Hanga Poukura, 1 female 1.8 mm (AMNH 18185). Hanga Tee, 1 male 1.5 mm (AMNH 18186). Easter I., 2 males 1.9–2.0 mm (AMNH 18187), 3 females 1.7–2.9 mm, discoloured specimens 1 male 1.9 mm, 1 female 1.6 mm (AMNH 18188). Easter I., 1 female 2.7 mm (AMNH 18189). Tongariki, 1 female 2.1 mm (AMNH 18190). Hanga Tee O Vaihu, discoloured specimens 2 males 1.3–1.7 mm (AMNH 18191). Hanga Tee O Vaihu, 6 males 1.4–3.4 mm, 4 females 1.4–2.2 mm, 1 juvenile 1.3 mm, discoloured specimens 6 juveniles 0.9–1.4 mm (AMNH 18192). La Pérouse Bay, 2 males 1.9–3.8 mm, discoloured specimens 2 males 1.1–1.4 mm, 1 female 1.0 mm, 5 juveniles 0.9–1.0 mm (AMNH 18193). Te Pito Kura, 3 males 2.3–2.9 mm, 1 female 1.8 mm, discoloured specimens 7 males 1.0–1.7 mm, 4 females 1.2–1.5 mm (AMNH 18194). Anakena, 2 males 1.6–3.5 mm, 2 females 1.6–2.2 mm (AMNH 18195). Anakena, 2 males 1.9–3.5 mm, 2 females 1.6–3.3 mm, discoloured specimen 1 female 1.3 mm (AMNH 18196). One Makihi, 1 male 4.4 mm (AMNH 18197). Hanga Roa, 2 males 2.8–4.4 mm, discoloured specimens 9 males 1.3–1.9 mm, 3 females 1.6–2.1 mm (MNHN Pg 6093).

Diagnosis. Ocular acicle with a single terminal spine. Ocular peduncle 0.7–1.0 times as long as shield; diameter of cornea included approximately 5 times in peduncular length. Anterolateral plate of branchiostegite with fringe of long setae

on its dorsal margin (no spinules). Left chela 0.8–1.3 times as long as shield, comparatively larger in adult males. Outer face of palm feebly granular, with several proximal tubercles; lower half with 2 or 3 circular or subcircular depressions; upper margin armed with 3–5 spiny tubercles; lower margin denticulated and carinate, carena continuing onto fixed finger (see remarks). Carpus armed with several stout spines along anterior and upper margins and on outer face. Right palm with 4 or 5 corneous-tipped spines on upper margin; outer face tuberculate. P3 with distinct brush of setae on ventral margin of dactyl and distal part of propodus; dactyl about 0.8 times as long as propodus. Telson armed with single spine on terminal margin of each posterior lobe.

Colour. (live coloration from Poupin, 1997). Shield and ocular peduncles green olive. Antennular and antennal peduncles yellow. Chelae green olive with purplish-blue spines and tubercles, tip of fingers white. Dactyls of chelae with 2 red spots near base, on inside and outside. P2 and P3 banded in light yellow, black, and green olive. Abdomen and telson white.

After 1.5 y in alcohol, coloration still clear on Easter I. specimens although slightly different from live coloration. Shield white, sometimes cream on distal half. Antennular and antennal peduncles chlorine yellow. Palms of chelae orange to brown, fading to white distally; tubercles and spines blue. Dactyls of chelae with 2 red spots near base, on inside and outside. P2 and P3 banded in white, red-brown, and orange.

Distribution. South Pacific 14–34° S. Eastern Australia to Easter I., including Vanuatu, New Caledonia, Norfolk I., Kermadec Is, and French Polynesia. Not found in the Indian Ocean or in North Pacific, and the report from these areas by Forest and McLaughlin (2000: 79) is erroneous (J. Forest, pers. comm.).

Habitat. This species is a non-obligate coral associate (genus *Pocillopora*). On Easter I. it uses gastropod shells of *Caducifer decapitata engleri*, *Erosaria caputdraconis*, *Fossarus cumin-gii*, *Neothais nesiotis*, *Nerita* sp., *Planaxis akuana*, *Pascula citrica*, and *Nodilittorina pyramidalis pascua*. Two specimens (AMNH 18187) were parasitised by the bopyrid isopod, *Pseudionella akuaku* Boyko and Williams, 2001.

Remarks. The occurrence of *Calcinus imperialis* in Easter I., although already mentioned by DiSalvo et al. (1988), had been overlooked in the taxonomic literature. These new collections are the second record of this species on Easter I. and show that it is very common around the island.

Examination of *Calcinus imperialis* specimens herein reported, reveals intraspecific variations. Unusual armament of the ocular acicle includes one additional small spine, on one or both sides (13 specimens out of 79) or up to three terminal spines, on one side (a single specimen). The distal brush of setae on P3 is somewhat weak on a few small specimens. The two or three circular or subcircular depressions on the outer face of the chela are attenuated, or even totally absent, on specimens smaller than 2.0 mm. The outer face of the palm is either regularly convex or only slightly concave on its lower half. In these cases identification can still be made by careful examination of the lower margins of the palm and fixed finger, which are almost always carinated. In combination with the armament

of the ocular acicle and telson, this character was very useful in identifying many juveniles lacking colour. The carina was missing only on a 1.6 mm female (AMNH 18188) although it was easily identified as *C. imperialis* by the faint remains of red spots at the bases of the dactyls of the chelae.

Calcinus vachoni Forest, 1958

Calcinus vachoni Forest, 1958: 285, figs 2, 3, 9, 10, 15, 19 (type locality: near Nha Trang, Vietnam).—Baba, 1982: 58.—Morgan, 1990: 11, fig. 2; 1991: 905, figs 60–62.—Gherardi and McLaughlin, 1994: 624.—Poupin, 1997: 712, figs 6e–f, 8a–f.—Shih and Lee, 1997: 22, figs 1–3.—Shih, 1998: 93, figs 33–35.—Kato and Okuno, 2001: 74.

Calcinus seurati.—Matsuzawa, 1977: pl. 79, fig. 3.—Miyake, 1983: 113.—Nomura et al., 1988: 113.—Takeda, 1994: 194, fig. 2. Not *Calcinus seurati* Forest, 1951.

Not *Calcinus vachoni*.—Lewinsohn, 1982: 53 (= *Calcinus guamensis* Wooster, 1984, see Distribution).

Material examined (all specimens from Easter I.). Los Motus, in *Pocillopora* coral, 1 male 3.7 mm (MZUC F1198, 3257). Te Pito Kura, 1 male 1.2 mm (AMNH 18198). Hanga Roa, discoloured specimens 1 male 1.6 mm, 1 female 1.7 mm (MNHN Pg 6094).

Diagnosis. Ocular acicle with 2–5 terminal spines. Anterolateral plate of branchiostegite with fringe of long setae on dorsal margin, unarmed. Outer face of left chela regularly convex, slightly granulate; lower margin of palm rounded; upper margin unarmed, rounded or weakly cornered. Right chela with 5–7 corneous spines on upper margin. Distal setation of P3 more pronounced than on distal P2 but not forming real brush of setae. Telson with 4–9 spines on left posterior lobe (3–5 on posterior margin and 1–4 on lateral margin) and 3–9 spines on right posterior lobe.

Colour (live coloration from Poupin, 1997). Ocular peduncle gray-blue to cream with a large dark patch of variable extension: from absent to almost covering all the peduncle. Antennular peduncle and its flagella, blue. Distal segment of antennal peduncle orange; flagellum orange. Cheliped almost totally gray-blue turning to white on fingers of chela. P2 and P3 uniformly cream. In Easter I. specimens examined herein coloration has almost totally faded.

Distribution. Widely distributed in Indo-West Pacific, 27°N–27°S. Mauritius, Western Australia, Vietnam, Taiwan, Micronesia, Japan, French Polynesia, and Easter I. According to Gherardi and McLaughlin (1994), the record from Somalia (Lewinsohn, 1982) is in fact referable to *Calcinus guamensis* Wooster, 1984.

Habitat. Hard bottom and facultative associate of *Pocillopora* corals. It uses gastropod shells of *Drupa* spp., *Drupella* spp., *Conus* spp., *Mitra* spp., *Latirus* spp., *Cymatium* spp., *Coralliophila* spp., and *Cronia* spp. (Shih and Lee, 1997: 25).

Remarks. Separation of the poorly preserved specimens herein reported of *Calcinus vachoni* from discoloured juveniles of *C. imperialis*, can be difficult. The characters that are most useful are: armament of ocular acicle and telson, aspect of left chela, and in the case of one specimen, faint traces of coloration (ocular peduncle, white with cream patch distally, and distal segment of antennular peduncle blue).

In armament of the ocular acicle and telson, general aspects of left and right chelae, and distal setation of P3, *Calcinus*

vachoni is similar to *Calcinus gouti* Poupin, 1997, from French Polynesia, and *Calcinus laurentae* Haig and McLaughlin, 1984, from Hawaii. However, these three species are very distinctive in their coloration (see Poupin, 1997; Hoover, 1998). The ocular peduncle is gray-blue to cream with a large dark patch in *C. vachoni*; orange with narrow white ring close to cornea in *C. laurentae*; and proximally pink, grading to pale pink or white distally in *C. gouti*. The distal antennular segment is blue in *C. vachoni*; light orange or white in *C. laurentae*; and white to cream in *C. gouti*. The chela is gray-blue turning to white distally in *C. vachoni*; brown turning to white distally in *C. laurentae*; and white or cream with a submedian dark spot on outer face in *C. gouti*. P2 and P3 are uniformly cream in *C. vachoni*; red-orange turning to pinkish distally in *C. laurentae*; and cream with pink rings in *C. gouti*. In addition to coloration, *Calcinus vachoni* is also distinguished by the upper margin of the left chela, unarmed and often weakly cornered, whereas it has some spines and is rounded in the two other species.

Discussion

Knowledge of the Easter Island *Calcinus* fauna has been obtained as result of past expeditions to the island. Since the first collections of Decapoda made during the 1904 Albatross *Eastern Pacific Expedition*, more than ten scientific missions have studied this fauna. The most important collections were obtained during the 1958 *Scripps Institution of Oceanography DOWNWIND Expedition*, with a rock dredge operated between 40 and 100 m, in La Pérouse Bay; the 1964–1965 Canadian British Columbia *Medical Expedition to Easter Island*, with many shore collections made by Messrs Efford and Mathias; the 1972 *Expedición de Isla de Pascua*, organised by the Instituto Central de Biología, Universidad de Concepción, with intertidal collections and SCUBA dives between 8 and 10 m; and the 1985 and 1986 *National Geographic Expedition*, with intensive collections from inshore to depths of 60 m, by SCUBA dives, and also baited traps around 100 m. As no special attention was paid to the *Calcinus* during these expeditions it is possible that more species occur around the island, especially in poorly sampled subtidal areas. Nonetheless, because of the large collection studied here, it can be stated that *Calcinus* species are reasonably well known. A comparison of Easter I. fauna with other places in the Indo-West Pacific (Table 1) shows that: (1) the Easter I. fauna is remarkably impoverished; (2) the island must be included in the Indo-West Pacific region; and (3) it is a distinct province.

Easter I. has a clearly depauperate *Calcinus* fauna compared to other Indo-West Pacific areas. Some species that are common and easily collected by hand in neighbouring French Polynesian Islands, such as *C. seurati* or *C. laevimanus*, are absent from Easter I. The Western Pacific has the richest fauna (22 species, Table 1) with a decline in the number of species to the east (18 species in French Polynesia, 11 species in Hawaii, and 3 species on Easter I.). This trend is similar to that observed in shore fishes (Randall, 1998, 1999). Such low number of species in Easter I. can be attributed to its isolation; low surface area which reduces the chance of settlement by

Table 1. Species of *Calcinus* in the western and central Pacific. Western Pacific: Japan to Australia, including Taiwan, Micronesia, and Indonesia. French Polynesia: Marquesas, Society, Tuamotu, Austral and Gambier. Species in bold occur only in one region.

Western Pacific (Asakura, 2002; Asakura and Nomura, 2001; Asakura and Tachikawa, 2000; Morgan, 1991; Poupin, 1997; Poupin and McLaughlin, 1998; Rahayu and Forest, 1999; Shih, 1998)
C. anani Poupin and McLaughlin, 1998; *C. areolatus* Rahayu and Forest, 1999; *C. argus* Wooster, 1984; *C. elegans* (H. Milne Edwards, 1836); *C. gaimardii* (H. Milne Edwards, 1848); *C. guamensis* Wooster, 1984; *C. haigae* Wooster, 1984; *C. imperialis* Whitelegge, 1901; *C. inconspicuus* Morgan, 1991 (Australia); *C. isabellae* Poupin, 1997; *C. kurozumii* Asakura and Tachikawa, 2000 (Mariana); *C. laevimanus* (Randall, 1840); *C. latens* (Randall, 1840); *C. lineapropodus* Morgan and Forest, 1991; *C. minutus* Buitendijk, 1937; *C. morgani* Rahayu and Forest, 1999; *C. pulcher* Forest, 1958; *C. revii* Poupin and McLaughlin, 1998; *C. seurati* Forest, 1951; *C. sirius* Morgan, 1991 (Australia); *C. spicatus* Forest, 1951; *C. vachoni* Forest, 1958.

French Polynesia (Poupin, 1997; Poupin and McLaughlin, 1998; Rahayu and Forest, 1999)

C. anani Poupin and McLaughlin, 1998; *C. elegans* (H. Milne Edwards, 1836); *C. gauti* Poupin, 1997 (Tuamotu and Society); *C. guamensis* Wooster, 1984; *C. haigae* Wooster, 1984; *C. hakahau* Poupin and McLaughlin, 1998 (Marquesas); *C. imperialis* Whitelegge, 1901; *C. isabellae* Poupin, 1997; *C. laevimanus* (Randall, 1840); *C. latens* (Randall, 1840); *C. minutus* Buitendijk, 1937; *C. morgani* Rahayu and Forest, 1999; *C. nitidus* Heller, 1865 (Tuamotu and Society); *C. orchidae* Poupin, 1997 (Marquesas); *C. revii* Poupin and McLaughlin, 1998; *C. seurati* Forest, 1951; *C. spicatus* Forest, 1951; *C. vachoni* Forest, 1958

Hawaii (Haig and McLaughlin, 1984; Hoover, 1998; Rahayu and Forest, 1999)

C. argus Wooster, 1984; *C. elegans* (H. Milne Edwards, 1836); *C. gaimardii* (H. Milne Edwards, 1848)?; *C. guamensis* Wooster, 1984; *C. haigae* Wooster, 1984; *C. hazletti* Haig and McLaughlin, 1984; *C. laevimanus* (Randall, 1840); *C. latens* (Randall, 1840); *C. laurentae* Haig and McLaughlin, 1984; *C. morgani* Rahayu and Forest, 1999; *C. seurati* Forest, 1951

Easter I. (this study)

C. imperialis Whitelegge, 1901; *C. pascuensis* Haig, 1974; *C. vachoni* Forest, 1958

oceanic larvae; subtropical nature with low sea temperature and low coral diversity; and monotonous rocky coast, offering few ecological niches.

The affinities of Easter I. are clearly with the Indo-West Pacific, and the island can be considered the easternmost outpost of this region. The three local *Calcinus* species do not have affinities with any of the eastern Pacific species: *C. californiensis* Bouvier, 1898, *C. explorator* Boone, 1930, and *C. obscurus* Stimpson, 1859. The eastern Pacific species are characterised by the upper margin of the right chela being smooth or only slightly granulated, whereas the Easter I. *Calcinus*, like almost all other Indo-West Pacific species, have four or five strong, corneous-tipped spines on this margin. The presence in Easter I. of *C. vachoni*, a species widely distributed in the Indo-West Pacific, is further evidence of the Indo-West Pacific affinities of the island. Moreover, the occurrence of *C. imperialis* points to the close affinities between Easter I. and islands that lie along the southern edge of the tropical Pacific such as those of south of Tuamotu, Rapa I., Kermadec I. and Norfolk I. A similar observation has been documented for molluscs by Rehder (1980: 14, figs 6–9).

Although hardly significant for such a limited number of species, the presence of one endemic species, *Calcinus pascuensis*, out of three present on the island, represents the highest percentage of endemism for the regions separated in Table 1. This high rate of endemism for *Calcinus* hermit crabs, combined with extreme geographical isolation, supports the view that this small island is a distinct biogeographic province within the Indo-West Pacific region.

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